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FOR

AN APPARATUS FOR CONNECTING A DISPLAY TO A BODY CASE OF AN ELECTRONIC DEVICE

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AN APPARATUS FOR CONNECTING A DISPLAY TO A BODY CASE OF AN ELECTRONIC DEVICE

Field

[0001] Embodiments of the invention generally relate to the field of electronics.

General Background

[0002] Over the past few years, there has been increased demand for tablet computers, especially in light of their portability. Operating from either external or portable power sources, conventional tablet computers feature a liquid crystal display (LCD) connected to and mounted on a body case.

[0003] According to one type of conventional tablet computer, the LCD is rotationally attached to the body case by a cylindrical shaft as described in a published Japanese Application No. JP-A-10-55227. As a result, the computer can operate either as a tablet computer when the LCD is positioned directly above the body case or as a laptop computer when the LCD is horizontally rotated about the shaft by approximately 180 degrees to fully exposed the keyboard.

[0004] For this conventional tablet computer, the shaft operates as a conduit for a display cable that electrically connects the LCD to circuitry within the body case. Hence, the shaft is designed to overlap the display cable in order to prevent the cable from being damaged during horizontal rotation of the LCD. However, this overlapping architecture possesses a number of disadvantages.

[0005] For instance, one disadvantage is that the tablet computer must be constructed with a predetermined thickness in order to provide sufficient clearance for the display cable upon exiting the shaft. Otherwise, when the LCD is rotated, the display cable may become crushed or pressed against the edges of the shaft. This will likely cause accelerated wear of the display cable, which may lead to increased reliability problems. As a result, thinner tablet computers cannot be developed without addressing this potential reliability concern.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Features and advantages of embodiments of the invention will become apparent from the following detailed description in which:

[0007] Figure 1 is a perspective view of an exemplary embodiment of an electronic device with a display placed in a first position.

[0008] Figure 2 is a perspective view of an exemplary embodiment of the electronic device of Figure 1 with the display placed in a second position.

[0009] Figure 3 is a perspective view of an exemplary embodiment of the electronic device of Figure 1 with the display placed in a third position.

[0010] Figures 4A and 4B are exploded views of an exemplary embodiments of a display support mechanism.

[0011] Figure 5 is an overhead view of an exemplary embodiment of the electronic device with the display placed in the first position.

[0012] Figure 6 is a cross-sectional view of the electronic device of Figure 5 along a cross-sectional line A-A.

[0013] Figure 7 is a cross-sectional view of the electronic device of Figure 5 along a cross-sectional line B-B.

[0014] Figure 8 is an exemplary embodiment of a slot illustrated in Figure 7 for maintaining the display support mechanism.

[0015] Figure 9 is an overhead view of an exemplary embodiment of the electronic device with the display placed in the second position.

[0016] Figure 10 is a cross-sectional view of the electronic device of Figure 9 along a cross-sectional line A-A.

[0017] Figure 11 is a cross-sectional view of the electronic device of Figure 9 along a cross-sectional line B-B.

[0018] Figure 12 is an overhead view of an exemplary embodiment of the electronic device with the display placed in the third position.

[0019] Figure 13 is a cross-sectional view of the electronic device of Figure 12 along a cross-sectional line A-A.

[0020] Figure 14 is a cross-sectional view of the electronic device of Figure 12 along a cross-sectional line B-B.

[0021] Figure 15 is a cross-sectional view of an alternative embodiment of the first opening associated with the electronic device.

[0022] Figure 16 an exemplary embodiment of the electronic device with the display support mechanism configured to

support concurrent rotation and translation of the display.

DETAILED DESCRIPTION

[0023] Embodiments of the invention set forth in the following detailed description generally relate to a display support mechanism that is deployed within a body case of an electronic device and is physically separate from a display interconnect. The body case comprises a plurality of openings, which may be pre-formed apertures to enable access to the interior of the body case. One opening is configured and positioned to minimize wear and tangling of the display interconnect. Another opening is configured and positioned to enable limited rotation and translation of the display support mechanism and the display attached thereto. Collectively, these openings enable thinner portable computers to be produced.

[0024] In the following description, certain terminology is used to describe various features of one or more embodiments of the invention. For instance, an "electronic device" is defined as an electronic product with a flat panel display that can be rotated and translated (i.e., translated). In this detailed description, for clarity sake, the electronic device is illustrated as a hand-held tablet computer that can be converted to a free-standing, portable computer. However, it is evident that the invention may be utilized in other

types of electronic devices including, but not limited or restricted to personal digital assistants, cellular telephones, digital cameras, video cameras, navigation systems, and the like.

[0025] Herein, the term "rotate" as well as varying tenses thereof is generally defined as the angular movement about an axis of rotation. Normally, the axis of rotation is fixed. For this detailed description, when used to denote a direction of rotation, the term "vertically rotate" (or any tense thereof) relates to rotation about a generally horizontal axis of rotation. Similarly, the term "horizontally rotate" (or any tense thereof) relates to rotation about a generally vertical axis of rotation. The terms "translate", "translation" or any tense thereof are defined as linear movement.

[0026] The term "interconnect" is any medium that is capable of transferring electrical signals from one point to another. Examples of an interconnect may include one or more electrical wires, any type of cable (e.g., flexible printed cable), optical fiber, or the like. A "display interconnect" is simply an interconnect coupled at one end to a display such as a flat panel display.

[0027] In general, Figures 1-3 provide perspective views of an exemplary embodiment of an electronic device 100. The

electronic device 100 comprises a display 110, which is rotationally mounted on a body case 130. In addition, the display 110 may be translated from a centralized location toward one end of the body case 130.

[0028] As shown, the electronic device 100 operates as a tablet computer when the display 110 is placed in a first position (see Figure 1). In this position, the display 110 is in a "portrait" orientation. In order for the electronic device 100 to operate as a portable computer, according to one embodiment of the invention, the display 110 is initially rotated and placed in a second position (see Figure 2). Then, the display 110 is translated toward an end of the body case 130 and placed in a third position (see Figure 3). In both of these positions, the display 110 is in a "landscape" orientation.

[0029] More specifically, as shown in Figure 1, the display 110 houses a flat panel display 112 as well as circuitry (not shown) for generating a displayable image on the flat panel display 112. Examples of the flat panel display 112 include, but are not limited or restricted to a liquid crystal display (LCD), a plasma display or the like.

[0030] When placed in the first position, the display 110 covers at least seventy percent of the top surface area of the body case 130. According to one embodiment of the

invention, the display 110 is configured to leave a cursor control device 150 accessible at all times, regardless of the selected position of the display 110. As an alternative embodiment, although not shown, the display 110 may be configured to cover the cursor control device 150 when the display 110 is in the first position.

[0031] The body case 130 comprises a first casing 132 and a second casing 140, which are rotationally coupled together by a hinge 145. According to one embodiment of the invention, the hinge 145 features one or more friction hinges (e.g., brake hinge). It is contemplated, however, that the hinge 145 need not include friction hinges when there is no need for maintaining the display 110 at an angled position.

[0032] Herein, the first casing 132 features the cursor control device 150 and a keyboard (not shown). The cursor control device 150 comprises a cursor guide 152 and one or more select buttons (e.g., buttons 154 and 156), which are positioned on a raised area 134 of the first casing 132. The raised area 134 is contoured to be complementary with a curvature of an edge 114 of the display 110.

[0033] For this embodiment of the invention, the cursor guide 152 enables a user to adjust the position of a cursor displayed on the flat panel display 112. The

cursor guide 152 may be configured in a variety of arrangements such as a track ball, touch pad or even a tactile device as shown. The dual select buttons 154 and 156 mimic the "left-select" and "right-select" buttons of a desktop mouse.

[0034] Additionally, one or more interfaces 160 are implemented along an edge 136 of the first casing 132. For instance, a first interface 162 may be configured as a bay for receipt of a portable memory device such as one or more of the following: a memory card (e.g., PCMCIA card), a digital versatile disc (DVD) or compact disc (CD), a digital tape, or a floppy disk. A second interface 164 may be configured as a communication port for receipt of an adapter of a peripheral device such as a printer, a modem, a desktop mouse, or another electronic device. Thus, the second interface 164 may be configured as a Universal Serial Bus (USB) port in accordance with USB version 2.0, a PS/2 port, an RJ-11 jack, an RS-232 connector or the like. Although not shown, it is contemplated that the interfaces 160 may be position at the second casing 140 in lieu of the first casing 132.

[0035] As further shown in Figure 1, an optional camera 170 may be rotationally coupled to a top edge 142 of the second casing 140. Such coupling may be accomplished by a friction hinge. It is contemplated that the friction

hinge may be biased to maintain the camera 170 in an upward facing direction to mitigate damage to the lens of the camera 170 during storage and transport.

[0036] Referring now to Figure 2, an exemplary embodiment of the electronic device 100 with the display 110 placed in a second position is shown. Mounted on a display support mechanism (not shown), the display 110 is horizontally rotated about an axis of rotation 200, which is located through the center of the display 110. Thus, when rotated approximately ninety degrees (90°) from the first position, the display 110 covers those portions of the first casing 132 and the second casing 140 adjacent to the hinge 145 of Figure 1.

[0037] According to one embodiment of the invention, the display 110 to horizontally rotates only in a single direction such as in a clockwise (CW) or counter-clockwise (CCW) direction. The direction of rotation is restricted in order to prevent unwanted rotation of the display 110. As an alternative embodiment, the display 110 may be configured to rotate in both the CW and CCW directions.

[0038] As the display 110 is rotated, a keyboard 210, integrated into a recessed area 138 of the first casing 132, is partially exposed. The keyboard 210 includes a plurality of keys associated with alphanumeric characters

and arranged in a manner consistent with a standard computer keyboard. However, the keyboard 210 is less than one-half the size of a normal portable computer keyboard.

[0039] In addition to the keyboard 210, one or more hot keys 220 integrated into the recessed area 138 of the first casing 132 are exposed. A "hot key" is a single key or a combination of keys that, when depressed, perform a task more quickly than by selecting entries from menus via the cursor control device 150. These tasks can be specified and programmed at manufacture or can be programmed by the user. Examples of tasks controlled by the hot keys 220 include starting an application, establishing network connectivity, commencing a power-down procedure, or the like.

[0040] Referring now to Figure 3, a perspective view of an exemplary embodiment of electronic device 100 is shown after the display 110 has been translated toward the top edge 142 of the second casing 140. Herein, the display 110 is now placed in the third position, where the keyboard 210 is fully exposed. Also, the display 110 is entirely positioned over the second casing 140. This allows the second casing 140 and the display 110 to be vertically rotated. Where the hinge 145 is a brake hinge, both the second casing 140 and the display 110 may be

maintained at a selected angle (α, where $\alpha \leq 90$) from a bottom surface 139 of the first casing 132.

[0041] Referring now to Figures 4A-4B, exploded views of exemplary embodiments of a display support mechanism 300 are shown. Of course, the display support mechanism 300 may be produced in a variety of physical configurations other than those illustrated. Regardless of its configuration, the display support mechanism 300 is configured to enable the display 110 to be rotated and translated over the body case 120.

[0042] For each of these embodiments, illustrated in Figures 4A and 4B, the display support mechanism 300 comprises a shaft 310 interconnecting a fastening element 320 and a securing element 330. Both the shaft 310 and elements 320 and 330 may be made of a rigid composition such as hardened plastic, metal, or the like. The shapes of the fastening and securing elements 320 and 330 are a design choice.

[0043] According to one embodiment of the invention, as shown in Figure 4A, the shaft 310 and securing element 330 are formed together as the same element. The shaft 310 comprises a first end 312 adapted for coupling to the fastening element 320. For instance, the first end 312 may be sized and configured for insertion into a cavity

322 of the fastening element 320, and thereafter, is retained by the fastening element 320.

[0044] As an example, the first end 312 may be a "snap-on" insert that is adapted to mate with a complementary female cavity 322 located on the fastening element 320. Alternatively, as another example, the first end 312 may be coupled to the fastening element 320 by another conventional coupling technique such as threads, welding, gluing, or the like.

[0045] According to another embodiment of the invention, as shown in Figure 4B, the shaft 310 and fastening element 320 may be formed together as a single element. The shaft 310 comprises a second end 314 that is coupled to the securing element 330 by utilizing any coupling technique. Of course, it is contemplated that the shaft 310 and elements 320, 330 may be configured as a single unit.

[0046] Herein, as further shown in both Figures 4A and 4B, the fastening element 320 is adapted for insertion into a socket 340 generally formed at the center of a bottom surface 350 of the display 110. The socket 340 is formed to securely retain the fastening element 320 inserted therein or additional fasteners (e.g., screws, rivets, etc.) may be used as shown in Figure 4B. This enables the display 110 to be rotated and translated in response to

rotation and translation of the display support mechanism 300.

[0047] Of course, it is contemplated that the fastening element 320 may be integrated into the display 110 or pre-formed as part of the display 110. For these embodiments, the display support mechanism 300 would comprise the shaft 310 adapted to the fastening element 320 (or display 110) and the securing element 330.

[0048] Referring to Figure 5, an overhead view of an exemplary embodiment of the electronic device 100 with the display 110 placed in the first position is shown. Herein, the body case 130 comprises a first opening 400 and a second opening 420. These openings 400 and 420 are formed within the second casing in close proximity to the center of the body case 130.

[0049] For this embodiment of the invention, the first opening 400 is adapted as a conduit for a display interconnect 430, which is used to electrically couple the flat panel display with circuitry (e.g., digital-to-analog converter, processor, chipset, memory, etc.) housed within the body case 130. The first opening 400 includes a plurality of perimeter edges 402-406. The first and second perimeter edges 402 and 403 collectively form a first interconnect retention area 410. Similarly, the

first, third and fourth perimeter edges 402, 404 and 405 form a second interconnect retention area 412, while the second, fourth and fifth perimeter edges 403, 405 and 406 form a third interconnect retention area 414. A channel 416 is formed between retention areas 412 and 414.

[0050] As described herein, the display interconnect 430 resides in the retention area 410 when the display 110 is placed in the first position. The display interconnect 430 also resides in retention areas 412 and 414, when the display 110 is in the second and third positions, respectively.

[0051] For this embodiment of the invention, the first perimeter edge 402 is configured with a convex curvature, shaped as an arc, to provide a smooth transition of the display interconnect 430 between retention areas 410 and 412. It is contemplated that the radius of the arc may be equal to the distance between the center of the body case 130 and the display interconnect 430. However, in other embodiments, the radius of the arc may be sized differently.

[0052] Herein, the second perimeter edge 403 is configured with an arc shaped curvature that is a mirror image of the first perimeter edge 402. However, it is contemplated that the second perimeter edge 403 may be substituted for

generally straight perimeter edges 407 and 408 as represented by dashed lines.

[0053] The other perimeter edges 404-406 generally form the channel 416 over which the display interconnect 430 can be moved between the second retention area 412 and the third retention area 414 as described below.

[0054] Referring still to Figure 5, the second opening 420 is shaped to limit the angle of rotation and translation of the shaft 310 of the display support mechanism 300. For this embodiment of the invention, the second opening 420 is keyhole-shaped with a linear channel portion 422 and an expanded portion 424 positioned adjacent to one end of the channel portion 422. In one embodiment, the expanded portion 424 is positioned at the center of the body case 130.

[0055] Defined by perimeter edges 426, 427 and a portion of perimeter edge 428, the expanded portion 424 is generally wider than the channel portion 422. This allow for rotation of the shaft 310 when the display 110 is adjusted between the first position (portrait orientation) and the second position (landscape orientation).

[0056] For this embodiment of the invention, the shaft 310 has a rectangular cross-sectional area having a length (L) exceeding the width of the channel portion 422 and a width

(W) slightly less than the width of the channel portion 422. The positioning and shape of the shaft 310 are selected to restrict rotation and translation of the display 110 attached thereto. For instance, when the shaft 310 is situated in a "length-wise" orientation as shown, translation of the display support mechanism 300 is precluded because a first side 316 of the shaft 310, perpendicular to a translation path provided by the channel 422, exceeds the width of the channel 422.

[0057] As further shown in Figure 5, the cross-sectional shape of the shaft 310 along with the shape of the perimeter edge 426 enable counter-clockwise (CCW) rotation of the shaft 310 by approximately ninety degrees (90°). However, any rotation beyond ninety degrees (and perhaps a few degrees of tolerance) is precluded since the first side 316 of the shaft 310 would come into contact with the perimeter edge 428. Similarly, the cross-sectional shape of the shaft 310 discourages CW rotation of the display 110 when placed in the first position. Normally, a second side 318 of the shaft 310 will come into contact with perimeter edge 427 upon commencement of such rotation (e.g., prior to completion of ten degrees of CW rotation).

[0058] Referring now to Figure 6, a cross-sectional view of the electronic device 100 of Figure 5 along a cross-sectional line A-A is shown. The display interconnect 430

passes through the first retention area 410 of the first opening 400 and resides within the display 110 and the body case 130. In particular, the display interconnect 430 electrically couples a circuit board 500 housed within the body case 130 with the flat panel display 112 housed within the display 110.

[0059] Referring now to Figure 7, a cross-sectional view of the electronic device 100 of Figure 5 along a cross-sectional line B-B is shown. Herein, the fastening element 320 of the display support mechanism 300 is inserted into the socket 340 and coupled to the display 110. Therefore, any rotation or translation of the display support mechanism 300 causes corresponding rotation or translation of the display 110.

[0060] As shown, the second opening 420 constitutes an opening for a slot 600 having a depth less than the length of the shaft 310 of the display support mechanism 300. The slot 600 is configured to enable rotation and translation of the display support mechanism 300. As an option, the slot 600 may also be configured to restrict rotation of the display support mechanism 300, and thereby, restrict rotation of the display 110.

[0061] According to one embodiment of the invention, the slot 600 comprises a first retention element 610 situated

at a first end 620 of the slot 600. The first retention element 610 provides a recess 630. When the display 110 is placed in the first position, the securing element 330 is partially inserted into the recess 630. The recess 630 is sized so that the first retention element 610 applies downward forces against the securing element 330. As a result, the display support mechanism 300 is maintained in this position even during rotation of the display 110. The securing element 330 is disengaged from the recess 630 only when lateral forces are applied for translation of the display 110.

[0062] As shown, the slot 600 further comprises a second retention element 640 situated at a second end 650 of the slot 600. The second retention element 640 is generally identical in construction to the first retention element 610 and provides a recess 660 sized to receive the securing element 330 of the display support mechanism 300.

[0063] As shown in Figure 8, flanges 670 and 680 may be attached to sidewalls of the slot 600. These flanges 670 and 680 extend toward each other so that the distance (d1) between flanges 670 and 680 is wider than any side of the shaft 310, most notably a cross-sectional length of the shaft 310. The distance (d2) between sidewalls of the slot 600 is of sufficient length to allow rotation of the securing element 330, but prevent unwanted lateral

movement (i.e., rocking) of the display support mechanism 300.

[0064] Referring now to Figure 9, an overhead view of an exemplary embodiment of the electronic device 100 with the display 110 placed in the second position is shown. Herein, the display 110 is now substantially centered over the body case 130. As a result, a portion of the keyboard 210 is visible.

[0065] After rotation of the display 110 by approximately ninety degrees (90°) in the CCW direction, the display interconnect 430 has moved along the first perimeter edge 402 from the first retention area 410 to the second retention area 412. In addition, the display support mechanism 300 has been rotated by ninety degrees (90°) in the CCW direction. As a result, the shaft 310 is rotated accordingly, and therefore, is now situated in a "width-wise" orientation where none of the sides of the shaft 310 that are perpendicular to the linear channel 422 exceed the width of the channel 422.

[0066] Referring now to Figure 10, a cross-sectional view of the electronic device of Figure 9 along a cross-sectional line A-A is shown. Upon rotation of the display 110, the display interconnect 430 is re-positioned through the first opening 400. Namely, the display interconnect 430

passes through the second retention area 412 of the first opening 400 and electrically couples the circuit board 500 housed within the body case 130 with the flat panel display 112 housed within the display 110.

[0067] Referring to Figure 11, cross-sectional view of the electronic device of Figure 9 along a cross-sectional line B-B is shown. Herein, the securing element 330 is rotated, but is still retained within the recess 630 formed by the retention element 610.

[0068] Referring now to Figure 12, an overhead view of electronic device 100 with the display 110 placed in the third position is shown. Herein, as represented by the positioning of the shaft 310, the display support mechanism has been translated upward along the channel 422. Now, the keyboard 210 is fully accessible by the user.

[0069] When placed into the third position, the display 110 covers a substantial portion of the second casing 140 of the body case 130, but does not cover the hinge 145 or the first casing 132. As a result, the hinge 145 may be used to vertically rotate the second casing 140 and the display 110.

[0070] As an optional feature, the display 110 comprises one or more spring-loaded fasteners 690 which becomes engaged

with a recessed area 695 of the body case 130 when the display 110 is placed in the third position. According to one embodiment of the invention, the spring-loaded fasteners 690 are detents to facilitate easier release when lateral forces are applied by the user to return the display 110 back to the second position.

[0071] Referring now to Figure 13, a cross-sectional view of the electronic device 100 of Figure 12 along cross-sectional line A-A is shown. The display interconnect 430 passes through the third retention area 414 of the first opening 400 and electrically couples the circuit board 500 housed within the body case 130 with the flat panel display 112 housed within the display 110.

[0072] Referring now to Figure 14, a cross-sectional view of the electronic device 100 of Figure 12 along cross-sectional line B-B is shown. Herein, the securing element 330 of the display support mechanism 300 becomes disengaged from the recess 630. The display support mechanism 300 is moved from the first end 620 to the second end 650 of the slot 600. Thereafter, the securing element 330 is inserted into the second recess 660 formed by the second retention element 640.

[0073] Referring now to Figure 15, a cross-sectional view of an alternative embodiment of the first opening 400

associated with the electronic device 100 of Figures 5, 9 and 12 is shown. Herein, a protective member 700 operates in cooperation with the first opening 400 in order to provide the display interconnect 430 additional protection against wear. According to one embodiment of the invention, the protective member 700 may be an extension of the display 110 so as to partially protrude into the first opening 400 of the body case 130. According to another embodiment of the invention, the protective member 700 may be an insert placed on the perimeter edges forming the first opening 400. The protective member 700 may be made of a composition having a coefficient of friction less than the material forming the body case 130.

[0074] As an alternative embodiment of the invention, it is contemplated that the transition of the electronic device 100 from a tablet PC orientation to a portable computer orientation may be accomplished by a two-position process, instead of a three-position process as described above. Namely, when rotated, the display 110 is translated toward the top end 142 of the body case 130. This requires the display 110 to be rotated and translated in a concurrent manner. Such operations may be accomplished by placement of a rack-and-pinion configuration within the slot 600 as shown in Figure 16.

[0075] For this embodiment of the invention, the slot 600 (positioned in the body case 130) comprises a rack 800, namely a plurality of protrusions along a first sidewall 810 of the slot 600. These protrusions are engaged with protrusions 820 placed on the securing element 330 of the display support mechanism 300 when the securing element 330 is rotated. As a result, the display support mechanism is translated during rotation as denoted by the arrow. Since the display support mechanism is fixedly coupled to the display, the display is concurrently rotated and translated as well.

[0076] While certain exemplary embodiments of the invention have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad aspects of various embodiments of the invention, and that these embodiments not be limited to the specific constructions and arrangements shown and described, since various other modifications are possible.